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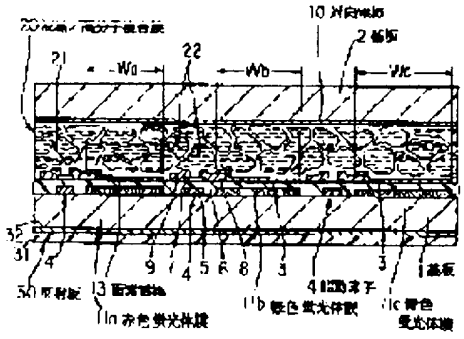
(54) ACTIVE MATRIX LIQUID CRYSTAL DISPLAY ELEMENT

(57)Abstract:

PURPOSE: To provide an active matrix liquid crystal display element with which a screen extremely brighter than the screen of a TN type is obtainable and even pixels of colors of low light intensity are displayed with a sufficient contrast.

CONSTITUTION: A combined liquid crystal/high polymer film 20 formed by dispersing liquid crystals into a high polymer layer is disposed between a rear surface side substrate 1 disposed with pixel electrodes 3 and active elements (TFTs) 4 and a front surface side substrate 2 provided with counter electrodes 10. The rear surface side substrate 1 is provided with red phosphor films 11a which emit red fluorescence, green phosphor films 11b which emit green fluorescence and blue phosphor films 11c which emit blue fluorescence by alternately lining up these films in respective correspondence to the respective pixel electrodes 3. In addition, the areas of the pixel electrodes 3 to which the blue phosphor films 11c having the low intensity of the generated fluorescence among the phosphor films for respective colors correspond are set larger than the areas of the pixel electrodes 3 to which the red and green phosphor films 11a, 11b having the high intensity of the generated fluorescence correspond.



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CLAIMS

[Claim(s)]

[Claim 1] The active matrix liquid crystal display element which is characterized by providing the following and which displays a color picture. The 1st substrate which arranged two or more active elements which are equivalent to two or more pixel electrode and each [these] pixel electrode, respectively. The counterelectrode which the aforementioned pixel electrode counters.

[Claim 2] The fluorescent substance film of two or more colors is an active matrix liquid crystal display element according to claim 1 characterized by the area of the pixel electrode to which it is with the red fluorescent substance film which emits red fluorescence, the green fluorescent substance film which emits green fluorescence, and the blue fluorescent substance film which emits blue fluorescence, and the aforementioned blue fluorescent substance film corresponds being larger than the pixel electrode to which the aforementioned red fluorescent substance film and a green fluorescent substance film correspond.

[Claim 3] The area of the pixel electrode to which a green fluorescent substance film corresponds is an active matrix than the pixel electrode to which a red fluorescent substance film corresponds.

[Claim 4] The area of the fluorescent substance film of each color is the active matrix liquid crystal display element of any one publication of the claim 1 characterized by being almost the same as the area of the pixel electrode to which the fluorescent substance film corresponds - the claim 3, respectively.

[Claim 5] It is the active matrix liquid crystal display element of any one publication of the claim 1 which the area of the pixel electrode to which the fluorescent substance film of each color corresponds differs mutually, and is characterized by the area of the fluorescent substance film of each aforementioned color being almost the same respectively, and the area being more than the area of the largest pixel electrode of the aforementioned pixel electrodes - the claim 3.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the active matrix liquid crystal display element which displays a color picture.

[0002]

[Description of the Prior Art]

element. A this TN type active matrix liquid crystal display element The 1st substrate which arranged two or more active elements which are equivalent to two or more pixel electrode and each [these] pixel electrode, respectively. While making the electrode forming face counter mutually, arranging the 2nd substrate which prepared the counterelectrode which the aforementioned pixel electrode counters and preparing the layer of a pneumatic liquid crystal between both this substrate The liquid crystal display element which arranges a polarizing plate, respectively and displays color pictures, such as a full color picture and a multicolor picture, on the superficies side of both the aforementioned substrates It has the composition of having made either of both the aforementioned substrates equivalent to each aforementioned pixel electrode, respectively, having arranged the light filter of two or more colors (for example, red, green, three blue colors) in by turns to it, and having prepared.

[0003] In addition, on the electrode forming face of both the aforementioned substrates, the orientation film which regulates the array direction of a liquid crystal molecule, respectively is prepared, and the molecule of liquid crystal is carrying out the twist array on about 90-degree twist square among both substrates. Moreover, the polarizing plate of the couple arranged at the external surface side of both substrates, respectively makes the transparency shaft of each other parallel mostly, and is prepared.

[0004]

[Problem(s) to be Solved by the Invention] However, the Above TN type active matrix liquid crystal display element has the problem that it is difficult to obtain the color display of sufficient luminosity. The linearly polarized light of the incident light from the outside is carried out with one polarizing plate, and it carries out incidence of this to a liquid crystal layer. The light which passed along the non-electric-field field (field which has a liquid crystal molecule in a twist array state) among the light which passed along the liquid crystal layer is absorbed with the polarizing plate of another side. In order that only the light passing through the electric-field impression field (field which the liquid crystal molecule started and arranged) may penetrate and carry out outgoing radiation of the polarizing plate of aforementioned another side, In order that the quantity of light loss by the optical absorption in a polarizing plate may be large, and may make only the light of the wavelength region of pinpointing [a light filter] of the lights penetrate and the light of other wavelength regions may absorb The color picture which is because the quantity of light loss by the optical absorption in a

light filter is also large, therefore is displayed will become quite dark compared with the luminosity of the incident light to a liquid crystal display element.

[0005] Especially the quantity of light loss by this optical absorption is remarkable in a rear-face side in the reflected type liquid crystal display element which has arranged the reflecting plate, a reflected type element Since the light which displays using the natural light or indoor lighting light, carries out [light] incidence from the front-face side of an element, and it is reflected by the reflecting plate by the side of a rear face, and carries out outgoing radiation to a front-face side passes along the polarizing plate and light filter of a couple by a unit of 2 times, respectively, a quantity of light loss becomes quite large, and a display image becomes extremely dark.

[0006] in addition, with the penetrated type element used for a rear-face side for a back light, arranging, to this reflected type element Since the light which carries out [light] incidence from a rear-face side, and carries out outgoing radiation to a front-face side only passes the polarizing plate and light filter of a couple along each by a unit of 1 time. Although the quantity of light loss by the optical absorption in a polarizing plate element, the luminosity of a display image still becomes quite dark compared with the luminosity of the lighting light from a back light.

[0007] And with the liquid crystal display element which the luminous intensities colored by the light filter of each color differ, for example, was equipped with the light filter of red, green, and blue, since it is extremely low, the conventional liquid crystal display element also has the problem that blue coloring luminous intensity has the thin display of a blue pixel compared with red and a green coloring light.

[0008] this invention lessens the loss of light sharply and aims at offering the active matrix liquid crystal display element which can display a very bright color picture and can moreover also display the pixel of a color with optical low intensity by sufficient thickness.

[0009]

[Means for Solving the Problem] The active matrix liquid crystal display element of this invention The 1st substrate which arranged two or more active elements which are equivalent to two or more pixel electrode and each [these] pixel electrode, respectively. While making the electrode forming face counter mutually, arranging the 2nd substrate which prepared the counterelectrode which the

macromolecule bipolar membrane which distributed liquid crystal in the macromolecule layer between both this substrate Make each aforementioned pixel electrode correspond, respectively, and arrange in by turns the fluorescent substance film of two or more colors which emit the fluorescence of a mutually different color at least to one side of both the aforementioned substrates, and it is prepared in it. And it is characterized by making larger than the pixel electrode to which a fluorescent substance film with the high intensity of generating fluorescence corresponds area of the pixel electrode to which a fluorescent substance film with the low intensity of generating fluorescence corresponds between two fluorescent substance films which emit the fluorescence of a different color.

[0010] In this invention, when it is with the red fluorescent substance film with which the fluorescent substance film of two or more aforementioned colors emits red fluorescence, the green fluorescent substance film which emits green fluorescence, and the blue fluorescent substance film which emits blue fluorescence, area of the pixel electrode to which the aforementioned blue fluorescent substance film corresponds at least is made larger than the pixel electrode to which the aforementioned red fluorescent substance film and a green fluorescent substance film correspond. In addition, it is more desirable to make larger than the pixel electrode to which a red fluorescent substance film corresponds area of the pixel electrode to which the aforementioned green fluorescent substance film corresponds in this case.

[0011] Moreover, may make area of the fluorescent substance film of each color almost the same as the area of the pixel electrode to which the fluorescent substance film corresponds, respectively, and Or only the area of the pixel electrode to which the fluorescent substance film of each color corresponds is changed mutually, and area of the fluorescent substance film of each aforementioned color may be made almost respectively the same, and should just carry out area of the fluorescent substance film of each color in that case more than the area of the largest pixel electrode of the aforementioned pixel electrodes.

[0012]

[Function] Namely, the active matrix liquid crystal display element of this invention is displayed using dispersion and transparency of the light in liquid crystal / macromolecule bipolar membrane, the light in which the molecule of the liquid crystal currently distributed in the macromolecule layer of this bipolar membrane has turned [light] to various directions in the state where electric field are not impressed, and passes along the aforementioned

bipolar membrane by this state is scattered about, and a pixel will be in a dark state. Moreover, if electric field are impressed between the pixel electrode of both the above-mentioned substrates, and a counterelectrode, it penetrates without the light by which a liquid crystal molecule starts and carries out orientation, and passes along the aforementioned bipolar membrane hardly receiving a light-scattering operation, and a pixel will be in the Ming state.

[0013] Moreover, since each aforementioned pixel electrode was made to correspond, respectively, the fluorescent substance film of two or more colors which emit the fluorescence of a color which is mutually different in at least one side of both the substrate was arranged in by turns and it has prepared in this liquid crystal display element, the color of the Ming display is a color of the fluorescence which the aforementioned fluorescent substance film emits, therefore a pixel can be colored, without using a light filter.

[0014] And since a polarizing plate indispensable to a TN type liquid crystal display element is unnecessary since it is what is displayed using dispersion and transparency of the light in liquid crystal / macromolecule bipolar membrane, and a light filter is also unnecessary in order for a fluorescent substance film to color a the optical absorption in a polarizing plate and a light filter.

[0015] Moreover, since it is what the above-mentioned fluorescent substance film makes only the light of the specific wavelength region of the lights penetrate like a light filter, the light of other wavelength regions absorbs, does not consider as coloring light, and emits fluorescence by the absorption luminous energy, the luminous intensity colored by this fluorescent substance film is far high compared with the coloring luminous intensity by the light filter.

[0016] Therefore, according to this liquid crystal display element, the loss of light can be lessened sharply and a very bright color picture can be displayed. The intensity of generating fluorescence and the area of the pixel electrode to which a low fluorescent substance film corresponds between two fluorescent substance films which emit the fluorescence of a different color in this liquid crystal display element Since it is made larger than the pixel electrode to which a fluorescent substance film with the high intensity of generating fluorescence corresponds, the intensity of the aforementioned generating fluorescence can display greatly the pixel colored with a low fluorescent substance film, i.e., a pixel with weak color intensity, and can also display the pixel of the low

[0017]

[Example] Hereafter, the example of this invention is explained with reference to a drawing. Drawing 1 is some cross sections of an active matrix liquid crystal display element showing the 1st example of this invention. In addition, the liquid crystal display element of this example is a reflected type thing which has arranged the reflecting plate 30 at the rear face.

[0018] In drawing 1 , the rear-face side substrate of a liquid crystal device and the upper substrate 2 of the lower substrate 1 are front-face side substrates. These substrates 1 and 2 are transparent substrates which consist of a glass plate etc., two or more transparent pixel electrodes 3 arranged in the line writing direction and the direction of a train and two or more active elements 4 which are equivalent to each [these] pixel electrode 3, respectively are arranged by the rear-face side substrate 1, it migrates to the whole surface mostly and the transparent counterelectrode 10 which all the pixel electrodes 3 of the above-mentioned rear-face side substrate 1 counter is formed in the front-face side substrate 2.

[0019] The above-mentioned active element 4 is TFT (TFT), this TFT4 The gate electrode 5 formed in the 1st page of the above-mentioned rear-face side substrate, and this gate electrode 5 The wrap gate insulator layer 6, It consists of a semiconductor film 7 which consists of a-Si which was made to counter with the aforementioned gate electrode 5, and was formed on the aforementioned gate insulator layer 6 (amorphous silicon), and the source electrode 8 and the drain electrode 9 formed on the both-sides section of this semiconductor film 7.

[0020] In addition, although not illustrated, the gate line (address line) which supplies a gate signal to the above TFT 4, and the data line which supplies the data signal according to image data to the above TFT 4 are wired by the rear-face side substrate 1, the gate electrode 5 of TFT4 was formed in the aforementioned gate line at one, and the drain electrode 9 is connected with the aforementioned data line.

[0021] Furthermore, each pixel electrode 3 arranged in this rear-face side substrate 1 is made to correspond, respectively, and red fluorescent substance film 11a which emits the fluorescent substance film of two or more colors which emit the fluorescence of a mutually different color to the above-mentioned rear-face side substrate 1, for example, red fluorescence, green fluorescent substance film 11b which emits green fluorescence, and blue fluorescent substance film 11c which emits blue fluorescence arrange by turns, and is prepared.

[0022] All, these fluorescent substance films 11a, 11b, and 11c absorb light, emit coloring fluorescence, and as the

fluorescent substance films 11a, 11b, and 11c of this example expanded and showed the part to drawing 2 , they mix a fluorescent substance 13 in the state of scattering into the transparent base material 12.

[0023] In addition, the above-mentioned transparent base material 12 is a transparent resin which consists of acrylic resin, vinyl chloride resin, alkyd resin, an aromatic sulfonamide resin, a urea resin, melamine resin, benzoguanamine resins, those ****** coalesce, etc.

[0024] Moreover, the above-mentioned fluorescent substance 13 has the detailed wavelength conversion function which this fluorescent substance 13 absorbs light other than a specific wavelength region (wavelength region of the fluorescence color which a fluorescent substance 13 emits) by grinding granular, and emits the light of the aforementioned specific wavelength region by the absorption luminous energy for the fluorescence material which dyed the resin or other transparent resins which were used for the above-mentioned base material 12 by the fluorescent dye.

[0025] The red system fluorescent substance which absorbs light other than a red wavelength region, and emits the light of a red wavelength region is used for above-mentioned red fluorescent system fluorescent substance which absorbs light other than a green wavelength region, and emits the light of a green wavelength region is used, to blue fluorescent substance film 11c The blue system fluorescent substance which absorbs light other than a blue wavelength region, and emits the light of a blue wavelength region is used. Therefore, red fluorescent substance film 11a emits the red fluorescence which the aforementioned red system fluorescent substance emits, green fluorescent substance film 11b emits the green fluorescence which the aforementioned green system fluorescent substance emits, and blue fluorescent substance film 11c emits the blue fluorescence which the aforementioned blue system fluorescent substance emits.

[0026] The above-mentioned fluorescent substance films 11a, 11b, and 11c what mixed the resin material and the fluorescent substance 13 which become the 1st page of a rear-face side substrate with a base material 12 at a desired rate It applies to predetermined thickness by print processes or the spin coat method, and is formed by the method of stiffening the account resin material of back to front, and these fluorescent substance films 11a, 11b, and 11c are covered by the gate insulator layer 6 of the above TFT 4.

[0027] This gate insulator layer 6 is a

electrode 3 is formed on the aforementioned gate insulator layer 6, and is connected to the source electrode 8 of TFT4 which corresponds in the end section.

[0028] Moreover, the pixel electrode 3 to which the above-mentioned red fluorescent substance film 11a corresponds, the pixel electrode 3 to which the above-mentioned green fluorescent substance film 11b corresponds, and the pixel electrode 3 to which the above-mentioned blue fluorescent substance film 11c corresponds change the area mutually, and are formed.

[0029] Thus, changing mutually the area of the pixel electrode 3 corresponding to the fluorescent substance films 11a, 11b, and 11c of each color is for the intensity of generating fluorescence to display greatly the pixel colored with a low fluorescent substance film, i.e., a pixel with a weak color, and to also display the pixel of the low color of optical intensity by sufficient thickness among the fluorescent substance films 11a, 11b, and 11c of each aforementioned color.

[0030] Namely, the red whom the above-mentioned red fluorescent substance film 11a, green fluorescent substance film 11b, and blue fluorescent substance film 11c emit, For the intensity of the fluorescence of green and blue, the intensity of the blue fluorescence which the intensity of the red fluorescence which differs mutually and red fluorescent substance film 11a emits is the highest, the intensity of the green fluorescence which green fluorescent substance film 11b emits is weaker than the aforementioned red fluorescence a little, and blue fluorescent substance film 11c emits is a low most.

[0031] The next [table 1] shows the result which measured the fluorescence intensity in the effective wavelength range, fluorescence peak wavelength, and peak wavelength of fluorescence which irradiate the natural light (white light) of the same intensity as the fluorescent substance films 11a, 11b, and 11c of each above-mentioned color, and each generates. In addition, the aforementioned effective wavelength range is a wavelength region of the fluorescence more than the intensity which can be used for a display, and fluorescence intensity is a relative value.

[0032]

[Table 1]

	青色蛍光	緑色蛍光	赤色蛍光
有効波長域 (nm) (帯域幅)	355~425 (70)	394~500 (106)	386~600 (214)
蛍光ピーク波長 (nm)	446	510	606
ピーク波長での 蛍光強度 (相対値)	967	1963	1205

[0033] As shown in this the [table 1], the red fluorescence which red fluorescent substance film 11a emits has the

fluorescence intensity as high as "1205" in peak wavelength, and as for the intensity of this red fluorescence, moreover, "386-600" are [the bandwidth] enough as an effective wavelength range for a latus (600-386=214) reason.

[0034] On the other hand, although the green fluorescence which green fluorescent substance film 11b emits has the fluorescence intensity quite as high as "1963" in peak wavelength, the bandwidth (500-395=106) compares an effective wavelength range with the bandwidth (214) of the aforementioned red fluorescence by "395-500", and since it is quite narrow, the intensity of this green fluorescence is a low a little from red fluorescence.

[0035] The blue fluorescence which blue fluorescent substance film 11c emits has the fluorescence intensity as low as "967" in peak wavelength, and moreover, also for an effective wavelength range, at "355-425", since the bandwidth (425-355=70) is still narrower than the bandwidth (106) of the aforementioned green fluorescence, the intensity of this blue fluorescence is a low more nearly further than green fluorescence.

[0036] Then, in this example, area of the pixel electrode 3 to which the intensity of generating fluorescence carries out sufficiently more greatly than the area of the pixel electrode 3 to which red area of the pixel electrode 3 to which low blue fluorescent substance film 11c corresponds most, and green fluorescent substance film 11b corresponds is enlarged a little from the area of the pixel electrode 3 to which the aforementioned red fluorescent substance film 11a corresponds.

[0037] It sets to drawing 1 and is Wa. The electrode width of face of the pixel electrode 3 to which red fluorescent substance film 11a corresponds, and Wb The electrode width of face of the pixel electrode 3 to which green fluorescent substance film 11b corresponds, and Wc It is the electrode width of face of the pixel electrode 3 to which blue fluorescent substance film 11c corresponds, and these pixel electrode width of face is Wa <Wb <Wc. It has a relation.

[0038] In addition, in this example, the pixel electrode 3 to which red fluorescent substance film 11a corresponds, the pixel electrode 3 to which green fluorescent substance film 11b corresponds, and the pixel electrode 3 to which blue fluorescent substance film 11c corresponds are formed by array pitch to which a these pixel inter-electrode interval becomes almost equal, and the fluorescent substance films 11a, 11b, and 11c of each color are formed in the respectively almost same area as the pixel electrode 3 to which it corresponds.

front-face side substrate 2 are joined through the sealant of the shape of a frame which is not illustrated at the periphery marginal part, and liquid crystal / macromolecule bipolar membrane 20 is formed in the field surrounded by these substrates 1 and the aforementioned sealant between two.

[0040] This liquid crystal / macromolecule bipolar membrane 20 distribute liquid crystal in a macromolecule layer, and this bipolar membrane 20 is making the structure where liquid crystal was confined in each opening section of the macromolecule layer 21 polymer-ized so that it might have a cross section like sponge, respectively. In drawing 1 , 22 is the liquid crystal section in a bipolar membrane 20 (portion in which liquid crystal was confined).

[0041] In addition, a dielectric anisotropy uses a positive pneumatic liquid crystal for the aforementioned liquid crystal, and the dichromatic dye of a black system is made to mix into this liquid crystal in this example. Drawing 3 is an expanded sectional view in the non-electric-field state and electric-field impression state of the one liquid crystal section 22 of the above-mentioned bipolar membrane 20, in drawing, A shows the molecule of liquid crystal and B shows the molecule of the aforementioned dichromatic dye.

[0042] The above-mentioned liquid crystal display element can be manufactured by the method of carrying out pouring restoration of the mixed solution of the polymeric materials which carry out polymerization reaction by light, and the liquid crystal which added the dichromatic dye by the vacuum pouring-in method, irradiating ultraviolet rays at this restoration solution, and making the aforementioned polymeric materials photopolymerizing from the inlet which a part of aforementioned sealant was made missing, and was formed between both this substrate 1 and 2, after joining the substrates 1 and 2 of a couple through a sealant. In addition, the aforementioned inlet is closed after photopolymerization of the restoration back of a solution, or a macromolecule.

[0043] Thus, if ultraviolet rays are irradiated at a substrate 1 and the above-mentioned mixed solution with which it was filled up among two, the polymeric materials in the state of a monomer or oligomer will serve as a macromolecule by the radical polymerization reaction which the radical of the molecule which radical-izes when the double bond is cleared, and adjoins each other combines mutually, and liquid crystal will carry out phase separation by polymer-ization of these polymeric materials.

[0044] For this reason, the polymer-ized macromolecule layer 21 has a cross section like sponge, liquid crystal is shut up by each crevice section of this

macromolecule layer 21, and the liquid crystal / macromolecule bipolar membrane 20 of the structure mentioned above are formed in it, respectively. The formation method of this bipolar membrane 20 is a method called photopolymerization phase separation method.

[0045] In addition, as for the UV irradiation to the above-mentioned restoration solution, it is desirable to carry out from the front-face side substrate [in which the counterelectrode 10 was formed] 2 side, and since the aforementioned counterelectrode 10 is an electrode of the shape of an one-sheet film of the front-face side substrate 2 mostly formed over the whole surface, if ultraviolet rays are irradiated from this front-face side substrate 2 side, it irradiates ultraviolet rays almost equally at the aforementioned whole restoration solution, and can obtain homogeneous liquid crystal / macromolecule bipolar membrane 20.

[0046] And after a liquid crystal display element forms above-mentioned liquid crystal / macromolecule bipolar membrane 20, it pastes up a reflecting plate 30 on the superficies (rear face) of the rear-face side substrate 1, and is completed. In addition, this reflecting plate 30 makes the reflective film 32 put on the front face of a base sheet 31 which (aluminum) film which split-face-ized the front face, a white reflective film with the light-scattering side which consists of Ba SO4 (barium sulfate), a specular reflection film which consists of Ag (silver).

[0047] The above-mentioned active matrix liquid crystal display element The molecule A of the liquid crystal of the liquid crystal section 22 which displays using dispersion and transparency of the light in liquid crystal / macromolecule bipolar membrane 20, and is distributed in 21 layers of macromolecules of this bipolar membrane 20 Since various directions are turned to in the state where electric field are not impressed as shown in (a) of drawing 3 , and the molecule B of a dichromatic dye has turned to various directions similarly, in the state of non-electric field In case the light which carried out incidence from the front-face side of a liquid crystal display element passes along the aforementioned bipolar membrane 20, while being scattered about by light-scattering operation of the interface of the liquid crystal section 22 and macromolecule layer 21 and the liquid crystal of the liquid crystal section 22, the greater part of this scattered light is absorbed by the dichromatic dye.

[0048] Small for this reason, the quantity of light which reaches the fluorescent

reflecting plate 30 on the back through the above-mentioned bipolar membrane 20 in the non-electric-field state -- **** -- Therefore, there are few amounts of fluorescence which the aforementioned fluorescent substance films 11a, 11b, and 11c emit, and amounts of reflected lights from the aforementioned reflecting plate 30, and Moreover, such light does not almost have the light which carries out outgoing radiation to a front-face side since it is scattered about and absorbed as it mentioned above, when it passed along the aforementioned bipolar membrane 20 again, and a display pixel will be in a black dark state mostly.

[0049] When electric field are impressed between the pixel electrode 3 of both the substrates 1 and 2, and a counterelectrode 10, moreover, as shown in (b) of drawing 3 In order to start uniformly, to carry out orientation so that the molecule A of the liquid crystal of the liquid crystal section 22 of the above-mentioned bipolar membrane 20 may become a perpendicular mostly to the 1 or 2nd page of a substrate, to take to it, and for the molecule B of a dichromatic dye to start and to carry out orientation, A bipolar membrane 20 is penetrated without hardly receiving absorption by the dichromatic dye, either without the light which carried out incidence receiving most light-scattering operations by the bipolar membrane 20 from the front-face side of a liquid crystal display element in the state of electric-field impression.

[0050] For this reason, in the electric-field impression state, while an incident light reaches the fluorescent substance films 11a, 11b, and 11c on the rear-face side substrate 1 through the above-mentioned bipolar membrane 20, the rear-face reflecting plate 30 of an element is also reached through these fluorescent substance films 11a, 11b, and 11c.

[0051] Moreover, the light which reached the reflecting plate 30 is reflected by this reflecting plate 30, in order that the light which reached the fluorescent substance films 11a, 11b, and 11c may make this fluorescent substance film 12 generate fluorescence, the light reflected by the reflecting plate 30 and the fluorescence which the fluorescent substance films 11a, 11b, and 11c emit penetrate the above-mentioned bipolar membrane 20 again, outgoing radiation is carried out to a front-face side, and a display pixel will be in the Ming state.

[0052] And red fluorescent substance film 11a which emits red fluorescence to the rear-face side substrate 1 in this liquid crystal display element, Since each pixel electrode 3 was made to correspond, respectively, and green fluorescent substance film 11b which emits green fluorescence, and blue fluorescent substance film 11c which emits blue fluorescence were arranged in by turns

and prepared, the color of the Ming display It is the color of the fluorescence of the red and green which these fluorescent substance films 11a, 11b, and 11c emit, and blue, therefore a display pixel can be colored, without using a light filter, and red, green, and color display by the combination of a blue pixel can be performed.

[0053] If coloring of the above-mentioned pixel is explained, it will set for the above-mentioned liquid crystal display element. Although it is reflected by the reflecting plate 30 of the rear face of an element through the fluorescent substance films 11a, 11b, and 11c as the light which penetrated liquid crystal / macromolecule composite 20 shows drawing 2 by the solid line arrow, and the reflected light carries out outgoing radiation through the fluorescent substance films 11a, 11b, and 11c again In case a certain amount of light of the light passes along a fluorescent substance film, it shines upon the fluorescent substance 13 currently distributed in the film.

[0054] or [and / that a fluorescent substance 13 makes the light of a specific wavelength region i.e., the light of the same wavelength region as the fluorescence color which a fluorescent substance 13 emits, penetrate among the light which shone upon this fluorescent absorbs and emits the light (fluorescence) of the aforementioned specific wavelength region by the luminous energy

[0055] In addition, although outgoing radiation of a part of fluorescence of them is carried out to the rear-face side of a fluorescent substance film since it is emitted to the circumference of a fluorescent substance 13 as the dashed line arrow showed the fluorescence which a fluorescent substance 13 emits to drawing 2 , it is reflected by the reflecting plate 30 and outgoing radiation of this fluorescence is again carried out to the front-face side through a fluorescent substance film. As for this, the same is said of the light reflected with the light and the fluorescent substance 13 which penetrated the fluorescent substance 13.

[0056] Therefore, the light which carries out outgoing radiation to the front-face side of the above-mentioned fluorescent substance films 11a, 11b, and 11c The light which penetrated the fluorescent substance film, without hitting a fluorescent substance 13, and the fluorescence emitted from the aforementioned fluorescent substance 13. Whether the aforementioned fluorescent substance 13 is penetrated Or since it is the reflected light (light of the same wavelength region as the fluorescence color which a fluorescent substance 13

hitting a fluorescent substance 13 is the white light. The color of the light which carries out outgoing radiation to the front-face side of the fluorescent substance films 11a, 11b, and 11c, i.e., the color of a pixel displayed, is a color of the fluorescence which the aforementioned fluorescent substance 13 emits. In addition, the concentration of the color of this pixel is decided by the amount of mixing of the fluorescent substance 13 in a fluorescent substance film.

[0057] Thus, since a polarizing plate indispensable to a TN type liquid crystal display element is unnecessary since it is what is displayed using dispersion and transparency of the light in liquid crystal / macromolecule bipolar membrane, and the fluorescent substance films 11a, 11b, and 11c can color a pixel and a light filter is also unnecessary, the above-mentioned liquid crystal display element does not have a quantity of light loss by the optical absorption in a polarizing plate and a light filter.

[0058] Moreover, the above-mentioned fluorescent substance films 11a, 11b, and 11c It is not what is made to penetrate only the light of the specific wavelength region of the lights like a light filter, and the light of other wavelength regions absorbs, and is made into coloring light. Since it is what emits fluorescence by the absorption luminous energy, the luminous intensity colored by these fluorescent substance films 11a, 11b, and 11c is far high compared with the coloring luminous intensity by the light filter. In addition, in order that the above-mentioned fluorescent substance films 11a and 11b and the fluorescent substance 13 in 11c may emit fluorescence not only by the light but by the wavelength light of the area outside a visible light pattern, the fluorescence emitted from the fluorescent substance films 11a, 11b, and 11c is the light of high brightness.

[0059] Therefore, according to the above-mentioned liquid crystal display element, the loss of light can be lessened sharply and a very bright color picture can be displayed. Moreover, in the above-mentioned example, since the dichromatic dye of a black system is made to mix into the liquid crystal of liquid crystal / macromolecule bipolar membrane 20, the color of a dark display is black, therefore the color picture displayed is a picture of high contrast.

[0060] In this liquid crystal display element, the intensity of generating fluorescence and the area of the pixel electrode 3 to which low blue fluorescent substance film 11c corresponds among red, green, and the fluorescent substance films 11a, 11b, and 11c that emit the fluorescence of each blue color Since it is made larger than the pixel electrode 3 to which red fluorescent substance film 11a with the high intensity of generating fluorescence and green fluorescent

substance film 11b correspond, the pixel colored by the aforementioned blue fluorescent substance film 11c, i.e., a blue pixel with weak color intensity, can be displayed greatly, and this blue pixel can also be displayed by sufficient thickness.

[0061] As mentioned above, moreover, the intensity of the green fluorescence which green fluorescent substance film 11b emits Although it is lower than the intensity of the red fluorescence which red fluorescent substance film 11a emits a little, in the above-mentioned example Since area of the pixel electrode 3 to which the aforementioned green fluorescent substance film 11b corresponds is also enlarged a little from the area of the pixel electrode 3 to which red fluorescent substance film 11a corresponds, The pixel colored by this green fluorescent substance film 11b, i.e., a green pixel, can be displayed somewhat greatly, and this green pixel can also display it by sufficient thickness.

[0062] In this case, if the surface ratio of each pixel electrode 3 to which red, green, and the blue fluorescent substance films 11a, 11b, and 11c correspond is chosen according to the intensity ratio of the fluorescence which the fluorescent substance films 11a, 11b, and 11c of each aforementioned color emit, although the color balance of red, green, and blue will also become good If area of the pixel considerably conspicuous and resolution will become bad, as for the surface ratio of each aforementioned pixel electrode 3, choosing in consideration of resolution is desirable.

[0063] In addition, although the fluorescent substance films 11a, 11b, and 11c in the above-mentioned example mix only a fluorescent substance 13 in the transparent base material 12 If the aforementioned fluorescent substance films 11a, 11b, and 11c are made to penetrate the light of the wavelength region corresponding to the color of the fluorescence which this fluorescent substance film emits and the light of other wavelength regions adds the color pigment (pigment used for the light filter) 14 to absorb as shown in drawing 4 Color purity of the light colored by the fluorescent substance films 11a, 11b, and 11c can be improved.

[0064] In this case, a red pigment is added to red fluorescent substance film 11a, a green pigment is added to green fluorescent substance film 11b, and a blue pigment is added to blue fluorescent substance film 11c. In addition, if a color pigment is added on the fluorescent substance films 11a, 11b, and 11c, since the light which passes along the fluorescent substance films 11a, 11b, and 11c will be absorbed to some extent by the aforementioned pigment, although the

pigment moderately, its color purity is good and, moreover, it can obtain coloring reflected light also with sufficient intensity.

[0065] Moreover, although the fluorescent substance films 11a, 11b, and 11c in the above-mentioned example mix a fluorescent substance 14 in the transparent base material 12, these fluorescent substance films 11a, 11b, and 11c may make a transparent base material put on a substrate, may dye this transparent base material by the fluorescent dye, and they may form.

[0066] Furthermore, with the liquid crystal display element of the above-mentioned example, although the reflecting plate 30 is formed in the superficies of the rear-face side substrate 1, it may replace with this reflecting plate 30, and a reflective film may be prepared in the inside side of the rear-face side substrate 1, and the fluorescent substance films 11a, 11b, and 11c may be formed in piles with the pixel electrode 3.

[0067] Drawing 5 is some cross sections of an active matrix liquid crystal display element showing the 2nd example of this invention. this example The reflective film 33 (the same thing as the reflective film 32 of the reflecting plate 30 shown in drawing 1) corresponding to each pixel electrode 3 is formed in the inside of the rear-face side substrate 1, respectively. While covering this reflective film 33 by the gate insulator layer (transparent membrane) 6 of TFT4 and forming the pixel electrode 3 on this gate insulator layer 6, the fluorescent substance films 11a, 11b, and 11c are formed on this pixel electrode 3.

[0068] In addition, in this example, although the fluorescent substance films 11a, 11b, and 11c were formed on the pixel electrode 3, the fluorescent substance films 11a, 11b, and 11c may be formed on the aforementioned gate insulator layer 6, and the pixel electrode 3 may be formed on it at this and reverse.

[0069] moreover, aluminum which split-face-ized the front face for the pixel electrode 3 which drawing 6 is some cross sections of an active matrix liquid crystal display element showing the 3rd example of this invention, and prepares this example in the rear-face side substrate 1 A film and Ag from -- form by the becoming mirror-plane film, this pixel electrode 3 is made to serve as a reflective film, and the fluorescent substance films 11a, 11b, and 11c are formed on this pixel electrode 3

[0070] In addition, if the example shown in above-mentioned drawing 5 and drawing 6 removes the point of having prepared the reflective film in the inside side of the rear-face side substrate 1, and having formed the fluorescent substance films 11a, 11b, and 11c in piles with the pixel electrode 3, since other composition is the same as the 1st example shown in drawing 1 , the overlapping explanation

attaches and omits a same sign to drawing.

[0071] Moreover, although the fluorescent substance films 11a, 11b, and 11c of each color are formed in the respectively almost same area as the pixel electrode 3 to which it corresponds in the above 1st - the 3rd example Change mutually only the area of the pixel electrode 3 to which the fluorescent substance films 11a, 11b, and 11c of each aforementioned color correspond. Area of the fluorescent substance films 11a, 11b, and 11c of each color may be made almost respectively the same, and should just carry out area of the fluorescent substance films 11a, 11b, and 11c of each color in that case more than the area of the largest pixel electrode of each pixel electrode 3.

[0072] That is, drawing 7 is some cross sections of an active matrix liquid crystal display element showing the 4th example of this invention. The liquid crystal display element of this example the area of the fluorescent substance films 11a, 11b, and 11c of each color, respectively While it is the same as the area of the largest pixel electrode 3 of each pixel electrode 3, i.e., the pixel electrode to which blue fluorescent substance film 11c corresponds, or enlarging slightly and arranging these fluorescent substance films 11a, 11b, and 11c at constant pitch from it The fluorescent substance films 11a, 11b, and 11c of each aforementioned color are made to correspond, respectively, the pixel electrode 3 which changed area like the above 1st - the 3rd example is formed, and other composition is the same as the 1st example shown in drawing 1 .

[0073] In addition, although area of the fluorescent substance films 11a, 11b, and 11c of each color is made the same as the area of the largest pixel electrode 3, therefore the marginal part of red fluorescent substance film 11a and green fluorescent substance film 11b has overflowed into the side of the pixel electrode 3 like drawing 7 in this example Since the flash section of this fluorescent substance film corresponds to the field where the electric field of liquid crystal / macromolecule bipolar membrane 20 are not impressed, i.e., the field absorbed by the dichromatic dye of a black system, while light is always scattered about, the portion corresponding to the flash section of the aforementioned fluorescent substance film will be in a black dark state mostly.

[0074] Moreover, although this 4th example is a modification of the 1st example of the above Also in the liquid crystal display element which prepared the reflective film in the inside side of the rear face side substrate 1 like the 2nd and 3rd examples mentioned above, and formed the fluorescent substance films 11a, 11b, and 11c in piles with the pixel electrode 3 Only the area of the pixel electrode 3 to which the fluorescent

substance films 11a, 11b, and 11c of each color correspond is changed mutually, and the area of the fluorescent substance films 11a, 11b, and 11c of each color is good respectively as for more than an area of the largest pixel electrode of each pixel electrode 3.

[0075] In addition, although area of the pixel electrode 3 to which green fluorescent substance film 11b corresponds is also enlarged a little in the above 1st - the 4th example from the area of the pixel electrode 3 to which red fluorescent substance film 11a corresponds the difference of the intensity of the green fluorescence which green fluorescent substance film 11b emits, and the intensity of the red fluorescence which red fluorescent substance film 11a emits -- **** -- since it is small, you may make almost the same as the area of the pixel electrode 3 to which red fluorescent substance film 11a corresponds area of the pixel electrode 3 to which the aforementioned green fluorescent substance film 11b corresponds

[0076] Moreover, in the above-mentioned example, although the pneumatic liquid crystal is used for the liquid crystal of liquid crystal / macromolecule bipolar membrane 20, this liquid crystal may be cholesteric liquid crystal, and since the molecular arrangement structure in a high, this cholesteric liquid crystal can indicate it darker by dark, and can make contrast of a display still higher.

[0077] Furthermore, in the above-mentioned example, although the dichromatic dye should be mixed for liquid crystal / macromolecule bipolar membrane 20 into liquid crystal, this bipolar membrane 20 may not be mixing the dichromatic dye into liquid crystal, and can perform the display by dispersion of the light in a non-electric-field state, and transparency of the light in an electric-field impression state also by that case. Moreover, not only TFT but MIM etc. is sufficient as an active element.

[0078] Moreover, in each example mentioned above, although the fluorescent substance films 11a, 11b, and 11c are formed in the rear-face side substrate 1, these fluorescent substance films 11a, 11b, and 11c may be formed in the front-face side substrate 2, and may form the fluorescent substance films 11a, 11b, and 11c in both the rear-face side substrate 1 and the front-face side substrate 2. In addition, when forming the fluorescent substance films 11a, 11b, and 11c in both substrates 1 and 2, the fluorescent substance films of the same color are made to counter mutually, and they are formed.

[0079] Moreover, although each liquid crystal display element of each

which formed the pixel electrode 3 and the active element (TFT) 4 Are good for this and reverse also considering the substrate 2 which formed the counterelectrode 10 as a rear-face side substrate. in that case What is necessary is to also make the aforementioned pixel electrode 3 into a transparent electrode. and to prepare a reflecting plate in the superficies of the rear-face side substrate 2. or just to prepare a reflective film in the inside of the aforementioned rear-face side substrate 2, while using as a transparent substrate the substrate (front-face side substrate) 1 which formed the pixel electrode 3 and the active element 4. In addition, when preparing a reflective film in the inside of the rear-face side substrate 2, you may make a counterelectrode 10 serve as a reflective film.

[0080] In addition, although the liquid crystal display element of each above-mentioned example displays a full color picture with the combination of the pixel of red, green, and blue this invention is a thing applicable also to the active matrix liquid crystal display element which displays a multicolor picture with the combination of the pixel of two or more colors. Also in that case. make each pixel electrode correspond, respectively, and arrange in by turns the fluorescent substance film of two or more colors which emit the fluorescence of a mutually different color to one [at least] substrate. and it is prepared in it. And between two fluorescent substance films which emit the fluorescence of a different color, if the intensity of generating fluorescence makes larger than the pixel electrode to which a fluorescent substance film with the high intensity of generating fluorescence corresponds area of the pixel electrode to which a low fluorescent substance film corresponds. it The intensity of the aforementioned generating fluorescence can display greatly the pixel colored with a low fluorescent substance film. i.e., a pixel with weak color intensity, and can also display the pixel of the color by sufficient thickness.

[0081] Moreover, although each liquid crystal display element of each above-mentioned example uses as a rear-face side substrate the substrate 1 which formed the pixel electrode 3 and the active element (TFT) 4 Are good for this and reverse also considering the substrate 2 which formed the counterelectrode 10 as a rear-face side substrate. in that case What is necessary is to also make the aforementioned pixel electrode 3 into a transparent electrode. and to prepare a reflecting plate in the superficies of the rear-face side substrate 2. or just to prepare a reflective film in the inside of the aforementioned rear-face side substrate 2. while using as a transparent substrate the substrate (front-face side substrate) 1 which formed

the pixel electrode 3 and the active element 4. In addition, when preparing a reflective film in the inside of the rear-face side substrate 2, you may make a counterelectrode 10 serve as a reflective film.

[0082] Furthermore, although each liquid crystal display element of each above-mentioned example is a reflected type thing, this invention is applicable also to a penetrated type active matrix liquid crystal display element.

[0083]

[Effect of the Invention] Since a polarizing plate indispensable to a TN type liquid crystal display element is unnecessary since it is what is displayed using dispersion and transparency of the light in liquid crystal / macromolecule bipolar membrane, and a fluorescent substance film can color a pixel and a light filter is also unnecessary, the active matrix liquid crystal display element of this invention does not have a quantity of light loss by the optical absorption in a polarizing plate and a light filter. Therefore, according to this liquid crystal display element, the loss of light can be lessened sharply and a very bright color picture can be displayed.

[0084] The intensity of generating fluorescence and the area of the pixel electrode to which a low fluorescent substance film corresponds between two liquid crystal display element of this invention Since it is made larger than the pixel electrode to which a fluorescent substance film with the high intensity of generating fluorescence corresponds, the intensity of the aforementioned generating fluorescence can display greatly the pixel colored with a low fluorescent substance film, i.e., a pixel with weak color intensity, and can also display the pixel of the color by sufficient thickness.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] Some cross sections of a liquid crystal display element showing the 1st example of this invention.

[Drawing 2] Some expanded sectional views of a fluorescent substance film.

[Drawing 3] The expanded sectional view in the non-electric-field state and electric-field impression state of the one liquid crystal section of liquid crystal / macromolecule bipolar membrane.

[Drawing 4] Some expanded sectional views of the fluorescent substance film which added the color pigment.

[Drawing 5] Some cross sections of a liquid crystal display element showing the 2nd example of this invention.

[Drawing 6] Some cross sections of a liquid crystal display element showing

liquid crystal display element showing the 4th example of this invention.

[Description of Notations]

1 2 -- Substrate

3 -- Pixel electrode

4 -- Active element (TFT)

10 -- Counterelectrode

11a -- Red fluorescent substance film

11b -- Green fluorescent substance film

11c -- Blue fluorescent substance film

12 -- Transparent base material

13 -- Fluorescent substance

14 -- Color pigment

20 -- Liquid crystal / macromolecule bipolar membrane

21 -- Macromolecule layer

22 -- Liquid crystal section

A -- Liquid crystal molecule

B -- Molecule of a dichromatic dye

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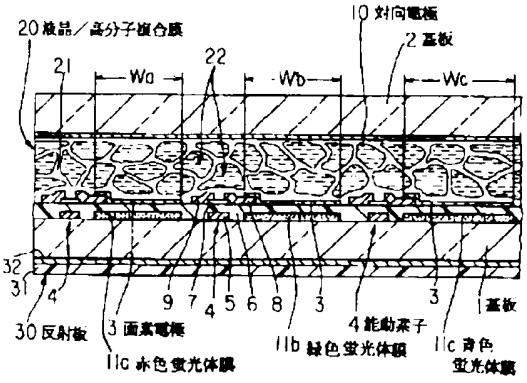
(54)【発明の名称】　アクティブマトリックス液晶表示素子

(57)【要約】

【目的】ＴＮ型のものに比べて非常に明るい画面を得ることができ、しかも光強度の低い色の画素も十分な濃さで表示することができるアクティブマトリックス液晶表示素子を提供する

【構成】画素電極３と能動素子（ＴＦＴ）４とを配設した裏面側基板１と、対向電極１０を設けた表面側基板２との間に高分子網中に液晶を分散させた液晶－高分子複合膜２０を設けるとともに、裏面側基板１に、赤の蛍光を発する赤色蛍光体膜１１ａと、緑の蛍光を発する緑色蛍光体膜１１ｂと、青の蛍光を発する青色蛍光体膜１１ｃとを、各画素電極３にそれぞれ対応させて交互に並べて設け、かつ、これら各色の蛍光体膜のうち発生蛍光の強度が低い青色蛍光体膜１１ｃが対応する画素電極３の面積を、発生蛍光の強度が高い赤および緑色蛍光体膜１



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【特許請求の範囲】

【請求項1】カラー画像を表示するアクティブマトリックス液晶表示素子であって、

複数の画素電極とこれら各画素電極にそれぞれ対応する複数の能動素子とを配設した第1の基板と、前記画素電極に対向する対向電極を設けた第2の基板とを、その電極形成面を互いに対向させて配置し、この両基板間に高分子層中に液晶を分散させた液晶、高分子複合膜を設けるとともに、前記両基板のうちいずれか一方に、互いに異なる色の蛍光を発する複数の色の蛍光体膜を前記各画素電極にそれぞれ対応させて交互に並べて設け、かつ、異なる色の蛍光を発する2つの蛍光体膜のうち発生蛍光の強度が低い蛍光体膜が対応する画素電極の面積を、発生蛍光の強度が高い蛍光体膜が対応する画素電極より大きくしたことを特徴とするアクティブマトリックス液晶表示素子。

【請求項2】複数の色の蛍光体膜は、赤の蛍光を発する赤色蛍光体膜と、緑の蛍光を発する緑色蛍光体膜と、青の蛍光を発する青色蛍光体膜とであり、前記青色蛍光体膜が対応する画素電極の面積が、前記赤色蛍光体膜および緑色蛍光体膜が対応する画素電極より大きいことを特徴とする請求項1に記載のアクティブマトリックス液晶表示素子。

【請求項3】緑色蛍光体膜が対応する画素電極の面積は、赤色蛍光体膜が対応する画素電極より大きいことを特徴とする請求項2に記載のアクティブマトリックス液晶表示素子。

【請求項4】各色の蛍光体膜の面積にそれぞれ、その蛍光体膜が対応する画素電極の面積とほぼ同じであることを特徴とする請求項1～請求項3のいずれか1つに記載のアクティブマトリックス液晶表示素子。

【請求項5】各色の蛍光体膜が対応する画素電極の面積が互いに異なっており、前記各色の蛍光体膜の面積はそれぞれほぼ同じで、かつその面積が、前記画素電極のうちの最も大きい画素電極の面積以上であることを特徴とする請求項1～請求項3のいずれか1つに記載のアクティブマトリックス液晶表示素子。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明はカラー画像を表示するアクティブマトリックス液晶表示素子に関するものである。

【0002】

【従来の技術】従来、アクティブマトリックス液晶表示素子としては、TN型のものが利用されている。このTN型のアクティブマトリックス液晶表示素子は、複数の画素電極とこれら各画素電極にそれぞれ対応する複数の能動素子とを配設した第1の基板と、前記画素電極が対向する対向電極を設けた第2の基板とを、その電極形成面を互いに対向させて配置し、この両基板間にネマティック液晶の層を設けるとともに、前記両基板の外面側にそれぞれ偏光板を配置したものであり、フルカラー画像やマルチカラー画像等のカラー画像を表示する液晶表示素子は、前記両基板のいずれか一方に、複数の色（例えば赤、緑、青の3色）のカラーフィルタを、前記各画素電極にそれぞれ対応させて交互に並べて設けた構成となっている。

【0003】なお、前記両基板の電極形成面上にはそれぞれ液晶分子の配列方向を規制する配向膜が設けられており、液晶の分子は両基板間においてほぼ90°のツイスト角でツイスト配列している。また、両基板の外面側にそれぞれ配置された一対の偏光板は、その透過軸を互いにほぼ平行にして設けられている。

【0004】

【発明が解決しようとする課題】しかし、上記TN型のアクティブマトリックス液晶表示素子は、十分な明るさのカラー表示を得るのが難しいという問題をもっている。これは、外部からの入射光が一方の偏光板により直線偏光されて液晶層に入射し、液晶層を通った光のうち、無電界領域（液晶分子がツイスト配列状態にある領域）を通った光は他方の偏光板で吸収され、電界印加領域（液晶分子が立上り配列した領域）を通った光だけが前記他方の偏光板を透過して出射するため、偏光板での光吸収による光量ロスが大きいし、またカラーフィルタが、可視光のうちの特定の波長域の光だけを透過させ他の波長域の光は吸収するために、カラーフィルタでの光吸収による光量ロスも大きいからであり、したがって、表示されるカラー画像が、液晶表示素子への入射光の明るさに比べてかなり暗くなってしまう。

【0005】この光吸収による光量ロスは、特に、裏面側に反射板を配置した反射型の液晶表示素子において顕著であり、反射型素子は、自然光または室内照明光を利用して表示するものであるし、また素子の表面側から入射し裏面側の反射板で反射されて表面側に出射する光が一対の偏光板とカラーフィルタをそれぞれ2度ずつ通るため、光量ロスがかなり大きくなって、表示画像が極端に暗くなる。

【0006】なお、この反射型素子に対し、裏面側にバックライトを配置して使用される透過型素子では、裏面側から入射して表面側に出射する光が一対の偏光板とカラーフィルタをそれぞれを1度ずつ通るだけであるため、前記反射型素子に比べれば偏光板およびカラーフィルタでの光吸収による光量ロスは小さいが、それでも、表示画像の明るさは、バックライトからの照明光の明るさに比べてかなり暗くなる。

【0007】しかも、従来の液晶表示素子は、各色のカラーフィルタによって着色された光の強度が異なっており、例えば赤、緑、青のカラーフィルタを備えた液晶表示素子では、青の着色光の強度が赤および緑の着色光に比べて極端に低いため、青の画素の表示が薄いという問

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題もっている。

【０００８】本発明は、光のロスを大幅に少なくして非常に明るいカラー画像を表示することができ、しかも光強度の低い色の画素も十分な濃さで表示することができるアクティブマトリックス液晶表示素子を提供することを目的としたものである。

【０００９】

【課題を解決するための手段】本発明のアクティブマトリックス液晶表示素子は、複数の画素電極とこれら各画素電極にそれぞれ対応する複数の能動素子とを配設した第１の基板と、前記画素電極が対向する対向電極を設けた第２の基板とを、その電極形成面を互いに対向させて配置し、この両基板間に高分子層中に液晶を分散させた液晶－高分子複合膜を設けるとともに、前記両基板の少なくとも一方に、互いに異なる色の蛍光を発する複数の色の蛍光体膜を前記各画素電極にそれぞれ対応させて交互に並べて設け、かつ、異なる色の蛍光を発する２つの蛍光体膜のうち発生蛍光の強度が低い蛍光体膜が対応する画素電極の面積を、発生蛍光の強度が高い蛍光体膜が対応する画素電極より大きくしたことを特徴とするものである。

【００１０】本発明において、前記複数の色の蛍光体膜が例えば、赤の蛍光を発する赤色蛍光体膜と、緑の蛍光を発する緑色蛍光体膜と、青の蛍光を発する青色蛍光体膜とである場合は、少なくとも前記青色蛍光体膜が対応する画素電極の面積を、前記赤色蛍光体膜および緑色蛍光体膜が対応する画素電極より大きくする。なお、この場合、前記緑色蛍光体膜が対応する画素電極の面積を、赤色蛍光体膜が対応する画素電極より大きくするのがより望ましい。

【００１１】また、各色の蛍光体膜の面積はそれぞれ、その蛍光体膜が対応する画素電極の面積とほぼ同じにしてもよいし、あるいは、各色の蛍光体膜が対応する画素電極の面積だけを互いに異なるせ、前記各色の蛍光体膜の面積はそれぞれほぼ同じにしてもよく、その場合は、各色の蛍光体膜の面積を、前記画素電極のうちの最も大きい画素電極の面積以上にすればよい。

【００１２】

【作用】すなわち、本発明のアクティブマトリックス液晶表示素子は、液晶－高分子複合膜での光の散乱と透過とを利用して表示するものであり、この複合膜の高分子層中に分散している液晶の分子は、電界が印加されていない状態では様々な方向を向いており、この状態では、前記複合膜を通る光が散乱されて画素が暗状態になる。また、上記両基板の画素電極と対向電極との間に電界を

する複数の色の蛍光体膜を、前記各画素電極にそれぞれ対応させて交互に並べて設けているため、明表示の色は、前記蛍光体膜が発する蛍光の色であり、したがって、カラーフィルタを用いることなく画素を着色することができる。

【００１４】そして、この液晶表示素子は、液晶－高分子複合膜での光の散乱と透過とを利用して表示するものであるため、ＴＮ型の液晶表示素子に必要不可欠な偏光板が不要であり、また蛍光体膜によって画素を着色するためにカラーフィルタも不要であるから、偏光板およびカラーフィルタでの光吸収による光量ロスが無い。

【００１５】また、上記蛍光体膜は、カラーフィルタのように可視光のうちの特定の波長域の光だけを透過させ他の波長域の光は吸収して着色光とするものではなく、吸収光のエネルギーによって蛍光を発するものであるため、この蛍光体膜で着色された光の強度は、カラーフィルタによる着色光の強度に比べてはるかに高い。

【００１６】したがって、この液晶表示素子によれば、光のロスを大幅になくして、非常に明るいカラー画像を表示することができる。しかも、この液晶表示素子においては、異なる色の蛍光を発する２つの蛍光体膜のうち発生蛍光の強度が低い蛍光体膜が対応する画素電極の面積を、発生蛍光の強度が高い蛍光体膜が対応する画素電極より大きくしているため、前記発生蛍光の強度が低い蛍光体膜によって着色される画素、つまり色強度の弱い画素を大きく表示して、光強度の低い色の画素も十分な濃さで表示することができる。

【００１７】

【実施例】以下、本発明の実施例を図面を参照して説明する。図１は本発明の第１の実施例を示すアクティブマトリックス液晶表示素子の一部分の断面図である。なお、この実施例の液晶表示素子は、その裏面に反射板３０を配置した反射型のものである。

【００１８】図１において、下側の基板１は液晶素子の裏面側基板、上側の基板２は表面側基板である。これら基板１，２はガラス或いはこれと同等の透明基板であり、裏面側基板１には、行方向および列方向に配列された複数の透明な画素電極３と、これら各画素電極３にそれぞれ対応する複数の能動素子４とが配設され、表面側基板２には、そのほぼ全面にわたって、上記裏面側基板１の全ての画素電極３が対向する透明な対向電極１０が設けられている。

【００１９】上記能動素子４は例えばＴＦＴ（薄膜トランジスタ）であり、このＴＦＴ４は、上記裏面側基板１面に形成されたゲート電極５と、このゲート電極５を覆

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【００２０】なお、図示しないが、裏面側基板１には、上記ＴＦＴ４にゲート信号を供給するゲートライン（アドレスライン）と、前記ＴＦＴ４に画像データに応じたデータ信号を供給するデータラインとが配線されており、ＴＦＴ４のゲート電極５は前記ゲートラインに一体に形成され、ドレイン電極９は前記データラインにつながっている。

【００２１】さらに、上記裏面側基板１には、互いに異なる色の蛍光を発する複数の色の蛍光体膜、例えば、赤の蛍光を発する赤色蛍光体膜１１ａと、緑の蛍光を発する緑色蛍光体膜１１ｂと、青の蛍光を発する青色蛍光体膜１１ｃとが、この裏面側基板１に配設する各画素電極３にそれぞれ対応させて、交互に並べて設けられている。

【００２２】これら蛍光体膜１１ａ，１１ｂ，１１ｃはいずれも、光を吸収して着色蛍光を発するものであり、この実施例の蛍光体膜１１ａ，１１ｂ，１１ｃは、図２にその一部分を拡大して示したように、透明基材１２中に蛍光物質１３を点在状態で混入したものである。

【００２３】なお、上記透明基材１２は、アクリル樹脂、塩化ビニル樹脂、アルキド樹脂、芳香族スルホンアミド樹脂、ユリア樹脂、メラミン樹脂、ベンゾグアナミン樹脂、およびそれらの共縮重合体等からなる透明樹脂である。

【００２４】また、上記蛍光物質１３は、上記基材１２に用いた樹脂または他の透明樹脂を蛍光染料で染めた蛍光材を微細な粒状に粉砕したものであり、この蛍光物質１３は、特定の波長域（蛍光物質１３が発する蛍光色の波長域）以外の光を吸収し、その吸収光のエネルギーにより前記特定の波長域の光を放出する波長変換機能をもっている。

【００２５】そして、上記赤色蛍光体膜１１ａには、赤の波長域以外の光を吸収して赤の波長域の光を発する赤色系蛍光物質が用いられ、緑色蛍光体膜１１ｂには、緑の波長域以外の光を吸収して緑の波長域の光を発する緑色系蛍光物質が用いられ、青色蛍光体膜１１ｃには、青の波長域以外の光を吸収して青の波長域の光を発する青色系蛍光物質が用いられており、したがって、赤色蛍光体膜１１ａは前記赤色系蛍光物質が放出する赤色蛍光を発し、緑色蛍光体膜１１ｂは前記緑色系蛍光物質が放出する緑色蛍光を発し、青色蛍光体膜１１ｃは前記青色系蛍光物質が放出する青色蛍光を発する。

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【００２６】上記蛍光体膜１１ａ，１１ｂ，１１ｃは、裏面側基板１面に、基材１２となる樹脂材料と蛍光物質１３とを所望の割合で混合したものを、印刷法またはスピンコート法等により所定の膜厚に塗布し、その後前記樹脂材料を硬化させる方法で形成されており、これら蛍光体膜１１ａ，１１ｂ，１１ｃは、上記ＴＦＴ４のゲート絶縁膜６で覆われている。

【００２７】このゲート絶縁膜６は、ＳｉＮ（窒化シリコン）等からなる透明膜であり、画素電極３は、前記ゲート絶縁膜６の上に設けられ、その一端部において対応するＴＦＴ４のソース電極８に接続されている。

【００２８】また、上記赤色蛍光体膜１１ａが対応する画素電極３と、上記緑色蛍光体膜１１ｂが対応する画素電極３と、上記青色蛍光体膜１１ｃが対応する画素電極３とは、その面積を互いに異ならせて形成されている。

【００２９】このように各色の蛍光体膜１１ａ，１１ｂ，１１ｃに対応する画素電極３の面積を互いに異ならせているのは、前記各色の蛍光体膜１１ａ，１１ｂ，１１ｃのうち、発生蛍光の強度が低い蛍光体膜によって着色される画素、つまり色の薄い画素を大きく表示して、光強度の低い色の画素も十分な濃さで表示するためである。

【００３０】すなわち、上記赤色蛍光体膜１１ａと、緑色蛍光体膜１１ｂと、青色蛍光体膜１１ｃとが発する赤、緑、青の蛍光の強度は互いに異なっており、赤色蛍光体膜１１ａが発する赤色蛍光の強度が最も高く、緑色蛍光体膜１１ｂが発する緑色蛍光の強度が前記赤色蛍光より若干弱く、青色蛍光体膜１１ｃが発する青色蛍光の強度が最も低い。

【００３１】次の「表１」は、上記各色の蛍光体膜１１ａ，１１ｂ，１１ｃに同じ強度の自然光（白色光）を照射してそれぞれが発生する蛍光の有効波長域と蛍光ピーク波長およびピーク波長での蛍光強度を測定した結果を示している。なお、前記有効波長域は表示に利用できる強度以上の蛍光の波長域であり、また蛍光強度は相対値である。

【００３２】

【表１】

	青色蛍光	緑色蛍光	赤色蛍光
有効波長域（nm）（帯域幅）	３５５～４２５（７０）	３９４～５００（１０６）	３８６～６００（２１４）
蛍光ピーク波長（nm）	４４６	５１０	６０６
ピーク波長での蛍光強度（相対値）	９６７	１９６３	１２０５

【００３３】この（表１）のように、赤色蛍光体膜１１ａが発する赤色蛍光は、ピーク波長での蛍光強度が「１２０５」と高く、しかも有効波長域が「３８６～６００」でその帯域幅が広い（６００－３８６＝２１４）ため、この赤色蛍光の強度は十分である。

【００３４】一方、緑色蛍光体膜１１ｂが発する緑色蛍光は、ピーク波長での蛍光強度が「１９６３」とかなり高いが、有効波長域は「３９５～５００」でその帯域幅（５００－３９５＝１０６）が前記赤色蛍光の帯域幅（２１４）に比べてかなり狭いため、この緑色蛍光の強度は赤色蛍光より若干低い。

【００３５】また、青色蛍光体膜１１ｃが発する青色蛍光は、ピーク波長での蛍光強度が「９６７」と低く、しかも有効波長域も「３５５～４２５」でその帯域幅（４２５－３５５＝７０）が前記緑色蛍光の帯域幅（１０６）よりさらに狭いため、この青色蛍光の強度は緑色蛍光よりもさらに低い。

【００３６】そこで、この実施例では、発生蛍光の強度が最も低い青色蛍光体膜１１ｃが対応する画素電極３の面積を、赤色蛍光体膜１１ａおよび緑色蛍光体膜１１ｂが対応する画素電極３の面積より十分大きくし、また、緑色蛍光体膜１１ｂが対応する画素電極３の面積を、前記赤色蛍光体膜１１ａが対応する画素電極３の面積より若干大きくしている。

【００３７】図１において、Waは赤色蛍光体膜１１ａが対応する画素電極３の電極幅、Wbは緑色蛍光体膜１１ｂが対応する画素電極３の電極幅、Wcは青色蛍光体膜１１ｃが対応する画素電極３の電極幅であり、これら画素電極幅は、Wa＜Wb＜Wcの関係にある。

【００３８】なお、この実施例では、赤色蛍光体膜１１ａが対応する画素電極３と、緑色蛍光体膜１１ｂが対応する画素電極３と、青色蛍光体膜１１ｃが対応する画素電極３とを、これら画素電極間の間隔がほぼ等しくなるような配列ピッチで形成し、各色の蛍光体膜１１ａ，１１ｂ，１１ｃをそれぞれ、それが対応する画素電極３とほぼ同じ面積に形成している。

【００３９】そして、上記裏面側基板１と表面側基板２とは、その外周縁部において図示しない枠状のシール材を介して接合されており、これら基板１，２間の前記シール材で囲まれた領域に、液晶／高分子複合膜２０が設けられている。

【００４０】この液晶／高分子複合膜２０は、高分子層中に液晶を分散させたものであり、この複合膜２０は、スポンジのような多孔質状の断面をもつようにポリマー化した高分子層２１の各空隙部にそれぞれ液晶が閉じ込められた構

０の１つの液晶部２２の無電界状態と電界印加状態における拡大断面図であり、図において、Aは液晶の分子を示し、Bは前記二色性染料の分子を示している。

【００４２】上記液晶表示素子は、例えば、一対の基板１，２をシール材を介して接合した後、この両基板１，２間に、前記シール材の一部を欠落させて形成しておいた注入口から、光によって重合反応する高分子材料と二色性染料を添加した液晶との混合溶液を真空注入法により注入充填し、この充填溶液に紫外線を照射して前記高分子材料を光重合させる方法で製造することができる。なお、前記注入口は、溶液の充填後か、あるいは高分子の光重合後に封止する。

【００４３】このように、基板１，２間に充填した上記混合溶液に紫外線を照射すると、モノマーあるいはオリゴマーの状態にある高分子材料が、その二重結合が解けることによってラジカル化し、隣り合う分子のラジカルが互いに結合し合うラジカル重合反応により高分子となって、この高分子材料のポリマー化により液晶が相分離する。

【００４４】このため、ポリマー化した高分子層２１はスポンジのような断面をもち、この高分子層２１の各隙間部にそれぞれ液晶が閉じ込められて、上述した構造の液晶／高分子複合膜２０が形成される。この複合膜２０の形成方法は、光重合相分離法と呼ばれる方法である。

【００４５】なお、上記充填溶液への紫外線照射は、対向電極１０を形成した表面側基板２側から行なうのが望ましく、前記対向電極１０は表面側基板２のほぼ全面にわたって形成された１枚膜状の電極であるため、この表面側基板２側から紫外線を照射すれば、前記充填溶液の全体にほぼ均等に紫外線を照射して、均質な液晶／高分子複合膜２０を得ることができる。

【００４６】そして、液晶表示素子は、上記液晶／高分子複合膜２０を形成した後、裏面側基板１の外面（裏面）に反射板３０を接着して完成される。なお、この反射板３０は、樹脂フィルムからなるシート３１の表面に反射膜３２を被着させたものであり、この反射膜３２は、表面を粗面化したＡｌ（アルミニウム）反射膜、$BaSO_4$（硫酸バリウム）からなる光散乱面をもった白色反射膜、Ag（銀）からなる鏡面反射膜等である。

【００４７】上記アクティブマトリックス液晶表示素子は、液晶／高分子複合膜２０での光の散乱と透過とを利用して表示するものであり、この複合膜２０の高分子２１層中に分散している液晶部２２の液晶の分子Aは、電界も印加されていない状態では図３の（ａ）のように様

に、この散乱光の大部分が二色性染料によって吸収される。

【００４８】このため、無電界状態では、上記複合膜２０を通って裏面側基板１上の蛍光体膜１１ａ，１１ｂ，１１ｃおよび裏面の反射板３０に達する光量は極く僅かであり、したがって、前記蛍光体膜１１ａ，１１ｂ，１１ｃが発する蛍光量および前記反射板３０からの反射光量がわずかしか、また、これらの光は前記複合膜２０を再び通る際に上述したように散乱および吸収されるから、表面側に出射する光がほとんど無く、表示画素がほぼ黒の暗状態になる。

【００４９】また、両基板１，２の画素電極３と対向電極１０との間に電界を印加すると、図３の（ｂ）のように、上記複合膜２０の液晶部２２の液晶の分子Ａが基板１，２面に対してほぼ垂直になるように一様に立上り配向し、それに連れて二色性染料の分子Ｂも立上り配向するため、電界印加状態では、液晶表示素子の表面側から入射した光が、複合膜２０での光散乱作用をほとんど受けることなく、また二色性染料による吸収もほとんど受けずに複合膜２０を透過する。

【００５０】このため、電界印加状態では、入射光が上記複合膜２０を通って裏面側基板１上の蛍光体膜１１ａ，１１ｂ，１１ｃに達するとともに、この蛍光体膜１１ａ，１１ｂ，１１ｃを通って素子の裏面反射板３０にも達する。

【００５１】また、反射板３０に達した光は、この反射板３０で反射され、蛍光体膜１１ａ，１１ｂ，１１ｃに達した光はこの蛍光体膜１２に蛍光を発生させるため、反射板３０で反射された光と蛍光体膜１１ａ，１１ｂ，１１ｃが発する蛍光とが上記複合膜２０を再び透過して表面側に出射し、表示画素が明状態になる。

【００５２】そして、この液晶表示素子においては、その裏面側基板１に、赤の蛍光を発する赤色蛍光体膜１１ａと、緑の蛍光を発する緑色蛍光体膜１１ｂと、青の蛍光を発する青色蛍光体膜１１ｃとを、各画素電極３にそれぞれ対応させて交互に並べて設けているため、明表示の色は、これら蛍光体膜１１ａ，１１ｂ，１１ｃが発する赤、緑、青の蛍光の色であり、したがって、カラーフィルタを用いることなく、表示画素を着色して、赤、緑、青の画素の組合わせによるカラー表示を行なうことができる。

【００５３】上記画素の着色について説明すると、上記液晶表示素子においては、液晶／高分子複合２０を透過した光が図２に実線矢印で示すように蛍光体膜１１ａ，１１ｂ，１１ｃを通って素子の裏面の反射板３０で反射され、その反射光が再び蛍光体膜１１ａ，１１ｂ，１１ｃを通って出射するか、その光のうちのある程度の光が、蛍光体膜を通る際にその膜中に分散している蛍光物質１３に当る。

【００５４】そして、蛍光物質１３は、この蛍光物質１３に当った光のうち、特定の波長域の光、つまり蛍光物質１３が発する蛍光色と同じ波長域の光は透過させるかまたは反射させ、他の波長域の光は吸収して、その光のエネルギーにより前記特定の波長域の光（蛍光）を放出する。

【００５５】なお、蛍光物質１３が発する蛍光は、図２に破線矢印で示したように、蛍光物質１３の周囲に放出されるため、そのうちの一部の蛍光は蛍光体膜の裏面側に出射するが、この蛍光は反射板３０で反射され、再び蛍光体膜を通ってその表面側に出射する。これは、蛍光物質１３を透過した光および蛍光物質１３で反射された光も同様である。

【００５６】したがって、上記蛍光体膜１１ａ，１１ｂ，１１ｃの表面側に出射する光は、蛍光体膜を蛍光物質１３に当らずに透過した光と、前記蛍光物質１３から放出された蛍光と、前記蛍光物質１３を透過するかまたは反射された光（蛍光物質１３が発する蛍光色と同じ波長域の光）であり、蛍光体膜を蛍光物質１３に当らずに透過した光は白色であるため、蛍光体膜１１ａ，１１ｂ，１１ｃの表面側に出射する光の色、つまり表示される画素の色は、前記蛍光物質１３が発する蛍光の色である。なお、この画素の色の濃度は、蛍光体膜中の蛍光物質１３の混入量によって決まる。

【００５７】このように、上記液晶表示素子は、液晶／高分子複合膜での光の散乱と透過とを利用して表示するものであるため、ＴＮ型の液晶表示素子に必要不可欠な偏光板が不要であり、また蛍光体膜１１ａ，１１ｂ，１１ｃによって画素を着色できるためには、カラーフィルタも不要であるから、偏光板およびカラーフィルタでの光吸収による光量ロスが無い。

【００５８】また、上記蛍光体膜１１ａ，１１ｂ，１１ｃは、カラーフィルタのように可視光のうちの特定の波長域の光だけを透過させ他の波長域の光は吸収して着色光とするものではなく、吸収光のエネルギーによって蛍光を発するものであるため、この蛍光体膜１１ａ，１１ｂ，１１ｃで着色された光の強度は、カラーフィルタによる着色光の強度に比べてはるかに高い。なお、上記蛍光体膜１１ａ，１１ｂ，１１ｃ中の蛍光物質１３は、可視光だけでなく、可視光帯域外の波長光によっても蛍光を発するため、蛍光体膜１１ａ，１１ｂ，１１ｃから発せられる蛍光は高輝度の光である。

【００５９】したがって、上記液晶表示素子によれば、光のロスを大幅に少なくして、非常に明るいカラー画像を表示することができる。また、上記実施例では、液晶／高分子複合膜２０の液晶中に黒色系の二色性染料を混入させているため、暗表示の色に黒であり、したがって、表示されるカラー画像は、高コントラストの画像である。

【００６０】しかも、この液晶表示素子においては、赤、緑、青の各色の蛍光を発する蛍光体膜１１ａ，１１

b，11cのうち発生蛍光の強度が低い青蛍光体膜11cが対応する画素電極3の面積を、発生蛍光の強度が高い赤蛍光体膜11aおよび緑蛍光体膜11bが対応する画素電極3より大きくしているため、前記青色蛍光体膜11cによって着色される画素、つまり色強度の弱い青色画素を大きく表示して、この青色画素も十分な濃さで表示することができる。

【0061】また、上述したように、緑蛍光体膜11bが発する緑色蛍光の強度は、赤蛍光体膜11aが発する赤色蛍光の強度より若干低いが、上記実施例では、前記緑蛍光体膜11bが対応する画素電極3の面積も、赤蛍光体膜11aが対応する画素電極3の面積より若干大きくしているため、この緑蛍光体膜11bによって着色される画素、つまり緑色画素もある程度大きく表示して、この緑色画素も十分な濃さで表示することができる。

【0062】この場合、赤、緑、青の蛍光体膜11a，11b，11cが対応する各画素電極3の面積比を、前記各色の蛍光体膜11a，11b，11cが発する蛍光の強度比に応じて選べば、赤、緑、青の色バランスもよくなるが、画素電極3の面積を大きくしすぎると、その色の画素がかなり目立つようになって解像度が悪くなるため、前記各画素電極3の面積比は、解像度を考慮して選ぶのが望ましい。

【0063】なお、上記実施例における蛍光体膜11a，11b，11cは、透明基材12に蛍光物質13だけを混入したものであるが、図4に示すように、前記蛍光体膜11a，11b，11cに、この蛍光体膜が発する蛍光の色に対応する波長域の光を透過させ他の波長域の光は吸収する着色顔料（カラーフィルタに用いられている顔料）14を添加すれば、蛍光体膜11a，11b，11cで着色された光の色純度を良くすることができる。

【0064】この場合は、赤色蛍光体膜11aには赤の顔料を添加し、緑色蛍光体膜11bには緑の顔料を添加し、青色蛍光体膜11cには青の顔料を添加する。なお、蛍光体膜11a，11b，11cに着色顔料を添加すると、蛍光体膜11a，11b，11cを通る光がある程度顔料に吸収されるため、その分だけ反射光の強度が若干低下するが、顔料の添加量を適度に選べば、色純度が良く、しかも強度も十分な着色反射光を得ることができる。

【0065】また、上記実施例における蛍光体膜11a，11b，11cは、透明基材12に蛍光物質14を混入したものであるが、この蛍光体膜11a，11b，11cは、基板上に透明基材を被着させ、この透明基材

cは、画素電極3と重ねて設けてもよい。

【0067】図5は本発明の第2の実施例を示すアクティブマトリックス液晶表示素子の一部分の断面図であり、この実施例は、裏面側基板1の内面に、各画素電極3にそれぞれ対応する反射膜33（図1に示した反射板30の反射膜32と同じもの）を設け、この反射膜33をTFT4のゲート絶縁膜（透明膜）6で覆って、このゲート絶縁膜6の上に画素電極3を形成するとともに、この画素電極3の上に蛍光体膜11a，11b，11cを設けたものである。

【0068】なお、この実施例では、画素電極3の上に蛍光体膜11a，11b，11cを設けたが、これと逆に、前記ゲート絶縁膜6の上に蛍光体膜11a，11b，11cを形成し、その上に画素電極3を設けてもよい。

【0069】また、図6は本発明の第3の実施例を示すアクティブマトリックス液晶表示素子の一部分の断面図であり、この実施例は、裏面側基板1に設ける画素電極3を、表面を粗面化したAl膜やAg合金からなる鏡面膜等で形成して、この画素電極3に反射膜を兼ねさせ、この画素電極3の上に蛍光体膜11a，11b，11cを設けたものである。

【0070】なお、上記図5および図6に示した実施例は、裏面側基板1の内面側に反射膜を設け、蛍光体膜11a，11b，11cを画素電極3と重ねて設けた点を除けば、その他の構成は図1に示した第1の実施例と同じであるが、重複する説明は図に同符号を付して省略する。

【0071】また、上記第1～第3の実施例では、各色の蛍光体膜11a，11b，11cをそれぞれ、それが対応する画素電極3とほぼ同じ面積に形成しているが、前記各色の蛍光体膜11a，11b，11cが対応する画素電極3の面積だけを互いに異なるせ、各色の蛍光体膜11a，11b，11cの面積はそれぞれほぼ同じにしてもよく、その場合は、各色の蛍光体膜11a，11b，11cの面積を、各画素電極3のうちの最も大きい画素電極の面積以上にすればよい。

【0072】さらに、図7は本発明の第4の実施例を示すアクティブマトリックス液晶表示素子の一部分の断面図であり、この実施例の液晶表示素子は、各色の蛍光体膜11a，11b，11cの面積をそれぞれ、各画素電極3のうちの最も大きい画素電極、つまり青色蛍光体膜11cが対応する画素電極3の面積と同じかそれより僅かに大きくし、これら蛍光体膜11a，11b，11cを一定ピッチで配設するとともに、前記各色の蛍光体

色の蛍光体膜１１ａ，１１ｂ，１１ｃの面積を最も大きい画素電極３の面積と同じにしており、したがって、赤色蛍光体膜１１ａおよび緑色蛍光体膜１１ｂの縁部は画素電極３の側方にはみ出しているが、この蛍光体膜のはみ出し部は、液晶／高分子複合膜２０の電界が印加されない領域、つまり常に光が散乱されるとともに黒色系の二色性染料によって吸収される領域に対応しているため、前記蛍光体膜のはみ出し部に対応する部分はほぼ黒の暗状態になる。

【００７４】また、この第４の実施例は上記第１の実施例の変形例であるが、上述した第２および第３の実施例のように裏面側基板１の内面側に反射膜を設け、蛍光体膜１１ａ，１１ｂ，１１ｃを画素電極３と重ねて設けた液晶表示素子においても、各色の蛍光体膜１１ａ，１１ｂ，１１ｃが対応する画素電極３の面積だけを互いに異ならせ、各色の蛍光体膜１１ａ，１１ｂ，１１ｃの面積はそれぞれ各画素電極３のうちの最も大きい画素電極の面積以上にしてもよい。

【００７５】なお、上記第１～第４の実施例では、緑色蛍光体膜１１ｂが対応する画素電極３の面積も、赤色蛍光体膜１１ａが対応する画素電極３の面積より若干大きくしているが、緑蛍光体膜１１ｂが発する緑色蛍光の強度と、赤蛍光体膜１１ａが発する赤色蛍光の強度との差は極く小さいため、前記緑蛍光体膜１１ｂが対応する画素電極３の面積は、赤蛍光体膜１１ａが対応する画素電極３の面積とほぼ同じにしてもよい。

【００７６】また、上記実施例では、液晶／高分子複合膜２０の液晶にネマティック液晶を用いているが、この液晶はコレステリック液晶であってもよく、このコレステリック液晶は、無電界状態での分子配列構造が螺旋構造をもっているため、光散乱性が高いから、暗表示をより暗くして、表示のコントラストをさらに高くすることができる。

【００７７】さらに、上記実施例では、液晶／高分子複合膜２０を、液晶中に二色性染料を混入したものとしているか、この複合膜２０は、液晶中に二色性染料を混入していないものでもよく、その場合でも、無電界状態での光の散乱と、電界印加状態における光の透過とによる表示を行なうことができる。また、能動素子は、ＴＦＴに限らずＭＩＭ等でもよい。

【００７８】また、上述した各実施例では、裏面側基板１に蛍光体膜１１ａ，１１ｂ，１１ｃを設けているが、この蛍光体膜１１ａ，１１ｂ，１１ｃは表面側基板２に設けてもよいし、裏面側基板１と表面側基板２の両方に蛍光体膜１１ａ，１１ｂ，１１ｃを設けてもよい。なお、両方の基板１，２に蛍光体膜１１ａ，１１ｂ，１１ｃを設ける場合は、同じ色の蛍光体膜同士を互いに対向させて形成する。

【００７９】また、上記各実施例の液晶表示素子は、いずれも、画素電極３と能動素子（ＴＦＴ）４を設けた基板１を裏面側基板としたものであるか、これと逆に、対向電極１０を設けた基板２を裏面側基板としてもよく、その場合は、画素電極３と能動素子４を設けた基板（表面側基板）１を透明基板とするとともに前記画素電極３も透明電極とし、裏面側基板２の外面に反射板を設けるか、あるいは前記裏面側基板２の内面に反射膜を設ければよい。なお、裏面側基板２の内面に反射膜を設ける場合は、対向電極１０に反射膜を兼ねさせてもよい。

【００８０】なお、上記各実施例の液晶表示素子は、赤、緑、青の画素の組合わせによってフルカラー画像を表示するものであるが、本発明は、２色以上の画素の組合わせによってマルチカラー画像を表示するアクティブマトリックス液晶表示素子にも適用できるものであり、その場合も、少なくとも一方の基板に、互いに異なる色の蛍光を発する複数の色の蛍光体膜を各画素電極にそれぞれ対応させて交互に並べて設け、かつ、異なる色の蛍光を発する２つの蛍光体膜のうち発生蛍光の強度が低い蛍光体膜が対応する画素電極の面積を、発生蛍光の強度が高い蛍光体膜が対応する画素電極より大きくすれば、前記発生蛍光の強度が低い蛍光体膜によって着色される画素、つまり色強度の弱い画素を大きく表示して、その色の画素も十分な濃さで表示することができる。

【００８１】また、上記各実施例の液晶表示素子は、いずれも、画素電極３と能動素子（ＴＦＴ）４を設けた基板１を裏面側基板としたものであるが、これと逆に、対向電極１０を設けた基板２を裏面側基板としてもよく、その場合は、画素電極３と能動素子４を設けた基板（表面側基板）１を透明基板とするとともに前記画素電極３も透明電極とし、裏面側基板２の外面に反射板を設けるか、あるいは前記裏面側基板２の内面に反射膜を設ければよい。なお、裏面側基板２の内面に反射膜を設ける場合は、対向電極１０に反射膜を兼ねさせてもよい。

【００８２】さらに、上記各実施例の液晶表示素子は、いずれも反射型のものであるが、本発明は、透過型のアクティブマトリックス液晶表示素子にも適用することができる。

【００８３】

【発明の効果】本発明のアクティブマトリックス液晶表示素子は、液晶／高分子複合膜での光の散乱と透過とを利用して表示するものであるため、ＴＮ型の液晶表示素子に必要不可欠な偏光板が不要であるし、また蛍光体膜によって画素を着色できるためにカラーフィルタも不要であるから、偏光板およびカラーフィルタでの光吸収による光量ロスが無い。したがって、この液晶表示素子によれば、光のロスを大幅に少なくして、非常に明るいカラー画像を表示することができる。

【００８４】しかも、本発明の液晶表示素子においては、異なる色の蛍光を発する２つの蛍光体膜のうち発生蛍光の強度が低い蛍光体膜が対応する画素電極の面積を、発生蛍光の強度が高い蛍光体膜が対応する画素電極

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より大きくしているため、前記発生蛍光の強度が低い蛍光体膜によって着色される画素、つまり色強度の弱い画素を大きく表示して、その色の画素も十分な濃さで表示することができる。

【図面の簡単な説明】

【図1】本発明の第1の実施例を示す液晶表示素子の一部分の断面図。

【図2】蛍光体膜の一部分の拡大断面図。

【図3】液晶／高分子複合膜の1つの液晶部の無電界状態と電界印加状態における拡大断面図。

【図4】着色顔料を添加した蛍光体膜の一部分の拡大断面図。

【図5】本発明の第2の実施例を示す液晶表示素子の一部分の断面図。

【図6】本発明の第3の実施例を示す液晶表示素子の一部分の断面図。

【図7】本発明の第4の実施例を示す液晶表示素子の一部分の断面図。

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【符号の説明】

1，2…基板

3…画素電極

4…能動素子（ＴＦＴ）

10…対向電極

11a…赤色蛍光体膜

11b…緑色蛍光体膜

11c…青色蛍光体膜

12…透明基材

13…蛍光物質

14…着色顔料

20…液晶／高分子複合膜

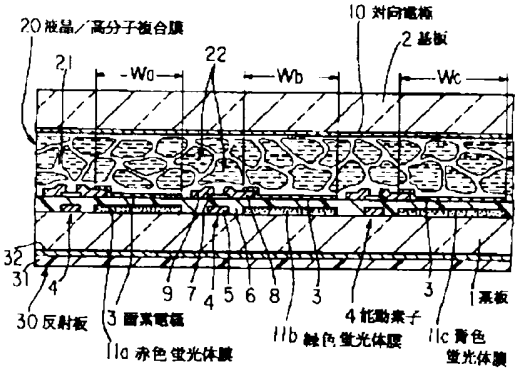
21…高分子層

22…液晶部

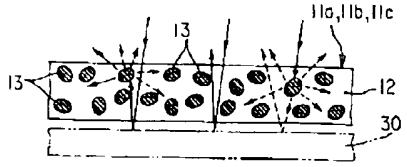
A…液晶分子

B…二色性染料の分子

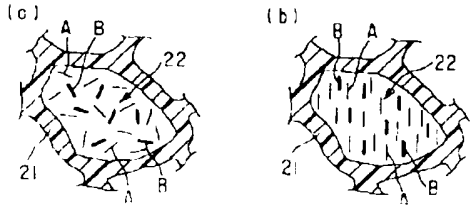
【図1】



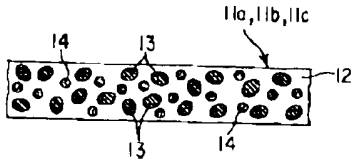
【図2】



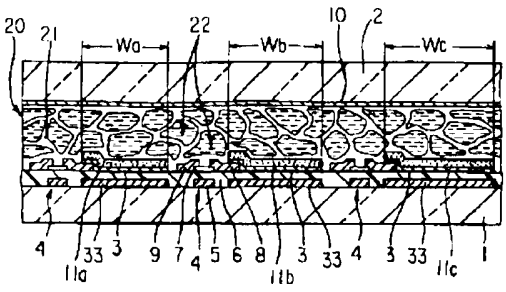
【図3】



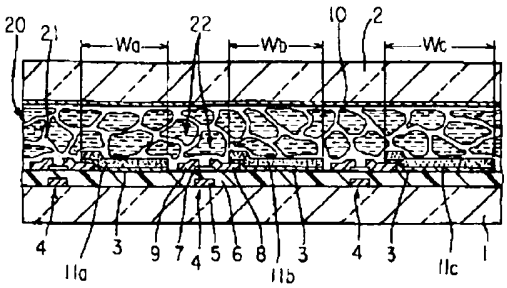
【図4】



【図5】


20
21
Wa
22
Wb
10
2
Wc
4
11a
33
3
9
7
4
5
6
8
11b
3
33
4
3
33
11c
1

【図6】


20
21
Wa
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Wb
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Wc
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11a
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4
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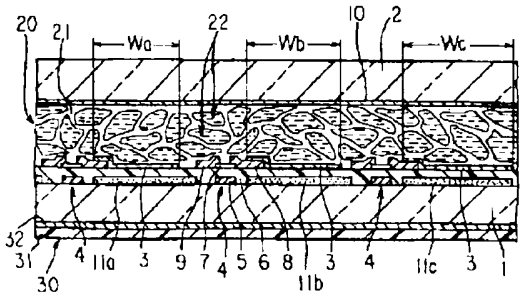
11b
3
4
3
11c
1

【図7】


20
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Wa
22
Wb
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2
Wc
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30
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11a
3
9
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4
5
6
8
11b
3
4
11c
3
1